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Diagnosis of Laboratories of Physics and Chemistry in the Universidad Tecnica de Manabi

Yadira del Pilar Chavez Loor [a]
Roxana Jacqueline Panchana Cedeno [b]
Daniel Alfonso Robaina [c]

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Abstract

The following work tries to diagnose the capacities in function of the management of the maintenance of the infrastructure of the laboratories of Physics and Chemistry of the Technical University of Manabí, having as reference the external and internal relations of the processes of maintenance, for the fulfillment Of this purpose a strategic diagnosis of the Universidad Técnica de Manabí (UTM) and the identification of the critical relations of the activities of maintenance of the laboratories of Physics and Chemistry of the UTM and its evaluation of the level of integration is realized.

Author correspondence:
Yadira del Pilar Chavez Loor,
Student of Master of Science,
Universidad Técnica de Manabí, Portoviejo, Ecuador
Email address : ychavez.loor@gmail.com

1. Introduction

In the world today, it has become a necessity of primordial order the improvements and updates in everything related to the educational field, above all in the matter of higher education; Which involves the organization, processes and management systems as tools that lead to achieve improvement in the quality standards that govern the parameters of education systems. It is valid to recognize that with the passage of the years there has been a positive evolution in education; Especially in Latin America, whose changes in this field were not very progressive, until current times in which significant improvements have been seen, Delgado *et al.,* (2015), Ecuador being one of the countries with the highest rate of progress in this regard.

Arcentales *et al.,* (2017), the process of accrediting universities as centers of excellence promotes in large measure knowledge of the situation in which the laboratories are located. In different countries, there are regulations for this

[a] Student of Master of Science, Universidad Tecnica de Manabi, Portoviejo, Manabi, Ecuador
[b] Student of Master of Science, Universidad Tecnica de Manabi, Portoviejo, Manabi, Ecuador
[c] Ph.D., Industrial Engineer Universidad tecnológica de la Habana

process where laboratory diagnostics are indispensable, in order to be able to evaluate the behavior of physical, chemical, mechanical and other magnitudes.

It is valued that every university must have a technical diagnosis of its laboratories, as a way of demonstrating that they have a management system, that Prasad *et al.,* (2017, Rivera-Borroto & Casañola-Martín (2017), are competent and that they are able to generate technically valid results, must operate in conformity with the requirements established in the ISO NC/IEC 17025, the criteria and policies of the accrediting body and the specific ones according to the field of application.

In the context of the changes taking place in Ecuador, the New Organic Law on Higher Education (LOES) was approved on August 4, 2010, with the purpose of seeking that higher education institutions contribute to the transformation of society, Its social, productive and environmental structure, training professionals and academics with the skills and knowledge that respond to the needs of national development and the construction of citizenship.

This Law regulates the system of higher education in the country, to the agencies and institutions that comprise it; Determines rights, duties, and obligations of natural and legal persons, and establishes the respective sanctions for non-compliance with the provisions contained in the Constitution and this Law.

With respect to the evaluation of quality, article 94 of the Organic Law of Higher Education (LOES) determines:

> *"The Quality Assessment is the process to determine the conditions of the institution, career or academic program, through the systematic collection of quantitative and qualitative data that allow to issue a judgment or diagnosis, analyzing its components, functions, processes, in order to that their results serve to reform and improve the curriculum, career or institution. Quality Assessment is a permanent process and involves continuous monitoring".*

In compliance with the constitution, the rules governing the Council of Higher Education, CES and the Commission for Evaluation, Huang Q. (2014), Pérez *et al.,* (2017) Accreditation and Quality Assurance of Higher Education CEAACES, in 2013 all the Institutions of Higher Education of Ecuador submitted to the Evaluation of each one of its IES placing them in categories A, B, C and D according to several criteria, sub-criteria and indicators. In this context, the Technical University of Manabí is currently located in category B.

The Technical University of Manabí, established in the city of San Gregorio de Portoviejo, was created by Legislative Decree issued on October 29, 1952, published in Official Register No. 085 of Thursday, December 11, 1952.

The Technical University of Manabí is an academic community of University character, oriented to teaching, constituted legally as a juridical person of public law without profit, who teaches higher academic education and fulfills activities of connection with society, in accordance with the objectives of the development regime and the principles established in the Constitution; Essentially pluralist and open to all the currents and forms of universal thought scientifically exposed; With full powers to organize within the provisions of the Constitution of the Republic of Ecuador, the Organic Law of Higher Education, its Regulations, other related laws, this Statute and the regulations issued to better organize the UTM.

In the year 2015, the UTM complied with the provisions of the Third General Provision of the Regulation for the Determination of Results of the Zambrano *et al.,* (2017), Evaluation and Categorization Process of Universities and Polytechnic Schools and their Academic and Institutional Situation, which establishes that Universities and Polytechnic schools that are in categories B and C may request their recategorization to CEAACES. The report of the institutional evaluation issued by CEAACES in April 2016 placed the UTM in category B with an overall performance of 51.12%. The model of evaluation, accreditation, and recategorization of Universities and Polytechnic Schools considered aspects such as Organization, Academia, Research, and Linkage with Society, Resources and Infrastructure and Students.

In the year 2015 began the process of evaluation of careers, beginning with the School of Medicine of the Faculty of Health Sciences; And will continue in 2016 and 2017 with the other University careers, (Faculty of Humanistic and Social Sciences, Faculty of Mathematical, Physical and Chemical Sciences, Faculty of Administrative and Economic Sciences, Faculty of Philosophy, Letters and Sciences of the Education, Faculty of Agricultural Engineering, Faculty of Veterinary Sciences, Faculty of Agricultural Engineering, Faculty of Zootechnical Sciences, Faculty of Health Sciences and Faculty of Computer Science).

In the base document provided by CEAACES to guide this evaluation process "Generic Model of Evaluation of the Learning Environment of Presence and Semi-Presence of the Universities and Polytechnic Schools of Ecuador" is specified in criterion D (Institutional Environment) (D3.1), equipment (D3.2) and availability (D3.3), which for the purpose of this research work would concentrate on the sub-criteria D3 (Laboratories / Simulation Centers / Workshops), 2 equipment and D3.3 availability.

According to this, it is very important to provide improvements in all areas of university, the academic priority of students often diverts attention only to the formation of them, leaving aside the physical aspect where this training takes place, suitable environments motivate the Student, teachers and all staff directly or indirectly involved in the training process.

The Physics and Chemistry laboratories located in the Institute of Basic Sciences of the UTM, represent an important part in the integral academic formation of the students, since it is here where practical classes are imparted to the students that within their curricular mesh, to From the first level to the fourth level, have subjects related to physics and chemistry, classes that are developed within a curriculum or syllabus and that is guided by the titular teacher of the subject related to these laboratories and who have a use for 4 hours Weekly by parallel, having an approximate of 100 parallels throughout the University that carry out their practices in these laboratories.

It should be emphasized that existing shortcomings, such as lack of reagents, lack and deterioration of equipment and materials, lack of control and monitoring of the materials and reagents used in the practices in these laboratories, as well as the damages that have arisen In the buildings due to the earthquake that occurred on April 16, 2016, causes that undermine the optimal development of academic activities and hinder the teaching-learning process.

As a consequence of the above, it is determined as a research problem: How to contribute to the improvement of the Physics and Chemistry Laboratories of the UTM. The object of study of this research will be: Maintenance management procedure for university laboratories, the field of action is determined as Maintenance management procedure based on CEAACES quality standards. To contribute to the solution of the research problem, it is determined as a general objective: To diagnose the processes involved in the maintenance management of the Physics and Chemistry Laboratories of the UTM.

2. Materials and Methods

Characterization of the institution

Ecuador in the decade of the 50, under the government of Mr. Galo Plaza Lasso, enters in a process of modernization, responding to the technological advances of Latin America. In this context and taking into account that our country and province were eminently agricultural, it was necessary to create an institution of Higher Education that offers professionals that respond to the academic demands of the province and the country. Thus the UTM was created by legislative decree on October 29, 1952. The President of the Republic Dr. José María Velasco Ibarra put the execution on November 21, 1952. The academic activity began in 1954.

The UTM is created with the Faculties of Agricultural Engineering and Veterinary Medicine, with the degrees of Agricultural Engineering, Agricultural Engineering and Veterinary Medicine.

Vision- The UTM's vision is to become a leading university institution, a reference to higher education in Ecuador, promoting the creation, development, transmission, and dissemination of science, technology, and culture, with social recognition, regional projection And worldwide.

Mission- The UTM's mission is to train responsible, humanistic, ethical and supportive academics, scientists and professionals who are committed to the objectives of national development, contributing to the solution of the country's problems as a university of teaching and research capable of generating And to apply new knowledge, promoting the promotion and dissemination of knowledge and cultures, as provided for in the Constitution of the Republic of Ecuador.

At present the university has 10 Faculties and 33 careers: Agronomic Engineering (Agronomic Engineering); Agricultural Engineering (Agricultural Engineering); Veterinary Medicine (Veterinary Medicine, Engineering in Aquaculture and Fishery); Mathematical, Physical and Chemical Sciences (Electrical Engineering, Mechanical Engineering, Civil Engineering, Industrial Engineering, Chemical Engineering); Philosophy, Literature and Education Sciences (Psychology and Vocational Guidance, Physics and Mathematics, Languages and Linguistics, Chemistry and Biology, Physical Education, Sports and Recreation, Arts Education, Basic General Education, Nursery Education); Administrative and Economic Sciences (Business Administration, Economics, Accounting and Auditing); Health Sciences (Nursing, Medicine, Optometry, Clinical Laboratory, Nutrition and Dietetics); Zootechnical Sciences (Zootechnical Engineering); Humanistic and Social Sciences (Social Work, Executive Secretariat, Library Science and Information Sciences, Clinical Psychology); Computer Science (Computer Systems Engineering).

The organizational structure of the UTM is exercised by the agencies and authorities, as shown in figure 1, being the Honorable University Council (HCU) the highest authority, in addition there are other departments associated with each direction that is constituted with the aim that the norms that are approved in the (HCU) are fulfilled. The

laboratories are currently managed by the faculties or directors of Institutes, who are responsible for the periodical diagnosis of the laboratories.

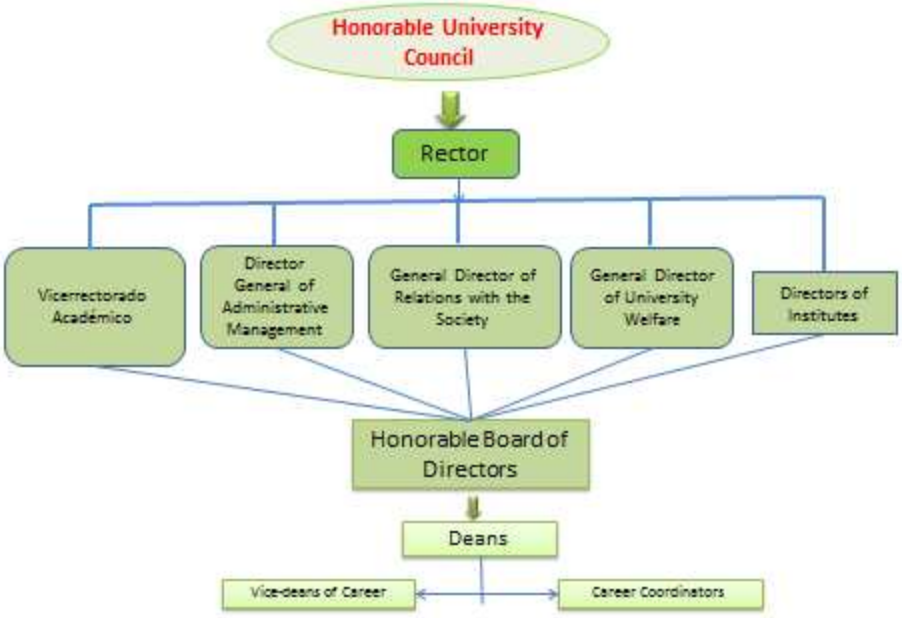


Figure 1. The organizational structure

Strategic Objectives

The University has among its strategic objectives the physical readjustment of its laboratories, at the present time the deans and vice-deans, the planning department and the department of university works are the most responsible for this activity. To look for financing alternatives to be able to construct in its 10 faculties laboratories that allow the students to acquire knowledge in a practical way and that can make simulations of subjects that today are in the curricular mesh, it is meritorious to point out that today it has as strength the laboratory in The Bahía de Caráquez Campus, with availability of aquaculture practices. Among the opportunities is that these laboratories that already exist can be certified in technical areas at the service of society.

One of the goals proposed by the university for the year 2013 was to train the helpers of computer labs so that they were prepared for the maintenance of existing computer equipment, achieving the stable fulfillment of this task.

Today, in spite of the difficulties caused by the earthquake in 2016, the University maintains a program to fulfill the strategic objectives, and to achieve the highest category with the proposed results achieved, being able to accredit their careers and where the laboratories of physics and chemistry are Of special connotation to graduate engineers with a high level of knowledge and prestige before the Society of Manabi.

The role of the laboratories in fulfilling the objectives of the University are directed to be able to go from a university of teaching to teaching with research, according to the typology of LOES, formulate and execute the master's training plan or master's degree in science for Its application, to achieve in an integral way the training and continuous improvement of professors and researchers, developing the Integral Research Plan (R & D & I), complying with the integral Program of Linkage with Society and achieving administrative efficiency within the Higher Education. These goals are projected to be met if, among other actions, the laboratories are managed with a stable maintenance according to the diagnoses that are made.

3. Results and Discussions

Analysis using the DAFO technique (weakness, threats, strengths, and opportunities)

Table 1 shows the mission of the university when analyzed with the SWOT technique it was found that there are strengths and weaknesses; among its weaknesses can be read the insufficiency of trained personnel and technological equipment in laboratories, is one of the problems studied in this research.

Table 1
Matrix of relation with respect to the mission of the UTM

Mission	Strengths	Weaknesses
The Technical University of Manabí has the mission of educating responsible, humanistic, ethical and supportive academics, scientists and professionals, committed to national development objectives, contributing to the solution of the country's problems as a university of teaching and research capable of generating And to apply new knowledge, promoting the promotion and dissemination of knowledge and cultures, as provided for in the Constitution of the Republic of Ecuador.	1. Offer careers according to the needs of the Zone Plan 4. 2. Have a teaching and administrative plant of the University that is of the locality. 3. There is a growing demand for third-level careers. 4. Have the Campus Portoviejo with the capacity to meet the demand, functional and pleasant with green areas.	1. Disarticulation between the PEDI, the budget proforma and the POA. 2. Insufficiency of trained personnel and technological equipment in laboratories. 3. Most classrooms do not have technological equipment (ICTs). 4. Lack of a risk assessment program and contingency plans.

Surveys were carried out among the experts involved in the development strategy of the laboratories for their maintenance and diagnosis. Regarding their importance in consideration of the strengths and weaknesses chosen which they considered more important and more incidents in the accomplishment of the mission, being the weighting of 1: very little, 2: medium and 3: Strongly, results that are plotted in Figure 2 and 3. As can be seen among the weaknesses weighted as strongly is the 02 that corresponds to the insufficiency of trained personnel and technological equipment in laboratories, noting that it is one of the elements in which we have to work to eradicate this Weakness, and achieve the indicative of the mission proposed by the university.

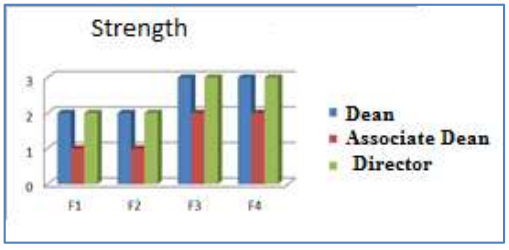


Figure 2. The weighting of strengths

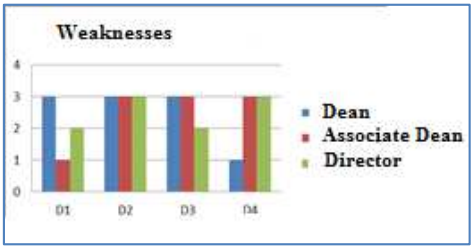


Figure 3. Weighting weaknesses

As can be seen, there is a coincidence between the criteria of the experts, among which stands out with a higher percentage of Strengths 3 and 4 and weaknesses 2, 3 and 4. In terms of the incidence of weaknesses in relation to the university's mission, the result is that weaknesses 2, 3 and 4 affect a higher percentage of the mission's results.

Table 2
Matrix of relation with respect to the vision

Vision	Opportunities	Threats
The UTM aims to become a leading university institution, a reference to higher education in Ecuador, promoting the creation, development, transmission, and dissemination of science, technology, and culture, with social recognition, regional and global projection.	1. Automation of Processes. 2. Quality Assurance. 3. The external sector requires that there be laboratories certified in technical areas at the service of the community. 4. Education Focused on Learning and Student Mobility.	1. Natural Disasters. 2. Possible reduction of state resources due to global economic crisis. 3. Under technological development in the region. 4. Conflicts of competence between the agencies that direct the system of Higher Education.

Among the opportunities and threats chosen, three experts (University authorities) were consulted about which ones they considered the most important and most incidents in the fulfillment of the vision, being weighted: 1: very little, 2: medium and 3: Strongly, These results can be observed in figure 4 the opportunities and in figure 5 the threats.

Figure 4. Weighting of opportunities

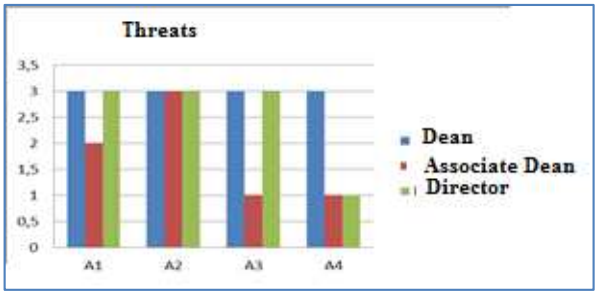


Figure 5. Weighting of threats

As can be seen, there is a coincidence between the criteria of experts, among which is highlighted with greater percentage of opportunities 2, 3 and 4 and threads 1, 2 and 3, with the highest level of incidence of threats with respect to vision Of the University that effect with a greater percentage to the attainment of the vision of the UTM:

From these results we can say that in order to efficiently fulfill the mission of the UTM, emphasis should be placed on strengthening weaknesses 2, 3 and 4, which are: Insufficiency of trained personnel and technological equipment in laboratories; Most classrooms do not have technological equipment (ICTs); Lack of a risk assessment program and contingency plans. In addition, in order to achieve the UTM vision, mitigation measures will have to be taken to mitigate the impact of the threats, with a higher percentage: Natural Disasters (1), possible reduction of state resources due to global economic crisis (2)) And Low technological development in the region (3).

Evaluation of the relations of the main processes of maintenance

Table 3 shows the relationship matrix of the key processes with the external entities. As can be seen in three of the external entities, the performance does not reach the highest rating and to analyze it in more detail, it can be seen in three of the Companies studied is regular.

Table 3
Matrix of Relations of the main processes with the external entities

Main processes	External entities							
	Color express		Compulaser		Ferreteria fabian		Coledidacticum (equipos de laboratorio)	
	I	D	I	D	I	D	I	D
Job ID	5	3	5	3	5	3	5	3
Planning Process							5	3
Programming Process			5	2			5	2
Process of assignment of work	4	3	5	2	5	2	5	2
Execution of repair needs	4	3	5	2	5	2	5	2
Analysis process	4	3	5	2	5	2	5	2

Importance
5 → Very good
4 → Important
3 → Moderately
2 → Little
1 → Less

Performance
5 → Excellent
4 → Very Good
3 → Good
2 → Regular
1 → Low

In Equation 1, the Enterprise System Integration Level (NISEext) can be calculated, where the critical relationships between the important ones are related, resulting in a value of 0.58.

$$NISEext = 1 - (\frac{RC}{RI}) \quad (1)$$

$NISDE_{EXT}$=1-(11/19)=0.58

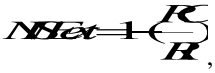
Table 4 shows the relationship matrix of the system integration level of the internal process company in which it can be observed that the processes of programming the execution of the repair needs and the analysis processes have values of 1 and 2 demonstrate that in these cases regular and low performances occur. Equation 2 shows the level of integration of the company's system, where the value obtained in the case of internal processes is 0.60, and it can be said that the values of the external entities differ from the values of the internal processes.

Table 4
Matrix of relations of internal processes

PROCESSES	Job ID		Planning Process		Programming Process		Process of assignment of work		Execution of repair needs		Analysis process	
	I	**D**	**I**	**D**	**I**	**D**	**I**	**D**	**I**	**D**	**I**	**D**
Job Identification + Maintenance Records			5	3	5	2	5	3				
Planning process + Human Group responsible for	5	4			5	2	5	3	5	2	5	1

maintenance management												
Programming Process + Maintenance Software							5	3	5	2	5	1
Work assignment process + Specialized technical staff									5	2	5	1
Execution of repair needs + Internal and external suppliers (suggestions)							4	3			5	1
Analysis Process + Internal Audits	5	3	5	2	5	2	5	3	5	2		

Applying equation (1)

 , se puede calcular que $NISDE_{EXT}$= 1-(12/20)= 0.60.

After having carried out the respective evaluation and related it with the processes of the internal and external entities, it is concluded that in the process of maintenance management in the UTM there is an integration level of 58% (External) and 60% (internal) So it is proposed to implement a maintenance management procedure that is based on computer software in which all the fixed assets of the University are registered with their respective maintenance plans and responsible for each process.

It is also considered that there is a need for a system of integration in the maintenance area with an operational manager who leads all related areas since the specialized personnel of the UTM carries out isolated activities which cause an inappropriate management of institutional resources.

4. Conclusion

The insufficient number of personnel trained in the maintenance of technological equipment in laboratories is the weakness that most limits the performance of the mission of the UTM in what concerns the laboratories of Physics and Chemistry, in addition, the possible diminution of the resources of the State by global economic crisis is the threat that can most affect the fulfillment of the vision of the university.

In the performance of the processes that affect maintenance management in the UTM, improvement possibilities can be observed from a low level of integration of the external system (0.58) and internal (0.60). Therefore, solutions are needed to strengthen the external and internal relations of the processes that affect maintenance management.

Conflict of interest statement and funding sources

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Statement of authorship

The authors have a responsibility for the conception and design of the study. The authors have approved the final article.

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Biography of Authors

Administrative public servant of the UTM, works as secretary I in the Dean of the Faculty of Mathematical Sciences, Physics and Chemistry, Student of Master of Science,
Universidad Técnica de Manabí, Portoviejo.
Email: ychavez.loor@gmail.com

Administrative public servant of the UTM, works as secretary I in the Dean of the Faculty of Mathematical Sciences, Physics and Chemistry, Student of Master of Science,
Universidad Técnica de Manabí, Portoviejo.

Vice-Rector of the Higher Polytechnic University "José Antonio Echeverría" (2015-present). Director of the Center for Studies in Management Techniques of the Institute Professor. PhD. in Technical Sciences (Polytechnic University Cujae. Industrial Engineer Universidad tecnológica de la Habana.